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THE TEA RESEARCH INSTITUTE.

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The Tea Research Institute of Ceylon.

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A REPORT ON DIRECT-FIRED AIR HEATERS

J. LAMB

In the *Tea Quarterly* (1940), XIII, p 73, the Shell Co. of Ceylon and R. C. Scott published details of "A New Type of Direct-Fired Air Heater for Drying Tea" which had been in use at Ottery Estate for two years. This heater is still in daily use and the cost of upkeep has been negligible over a period of seven years. The simple construction of this Direct Fired (D.F.) heater, illustrated and explained in the article referred to, makes it obviously less costly to build than a tubular stove, whilst the theoretical possibility of high efficiency is borne out by figures shewing a cost of operation relatively low for drying by liquid fuel. These three factors, namely :—

- (a) Low cost of construction
- (b) Low cost of upkeep.
- (c) High thermal efficiency.

are the most important factors in the costing of air heater operations and are therefore major considerations in the cost of drying tea.

It will probably strike the reader that factor (c) would have been more neatly expressed as "Low cost of operation." Unfortunately, however, high thermal efficiency does not result in a correspondingly low cost of operation unless the cost per heat unit in the fuel employed is comparatively low. Obviously a heater operating on, say, Liqueur Brandy would be expensive to run however high the thermal efficiency (it is now necessary to add qualifications about atomic energy).

For many years the Tea Research Institute has emphasised the relative cheap-

ness of heat units grown on the estate in the form of fuel trees planted in clearings, swamps, ravines, etc., and has practised on St. Coombs Estate what it has preached in the *Tea Quarterly*. We have also pointed out the possibilities for a local fuel industry with much less effect.

During the war the supply of estate grown fuel was not sufficient to keep prices down and many contractors were quick to start what was virtually a "Black Market" in firewood. Fortunately, the oil companies, despite shipping difficulties and risk to life and limb, were able to supply adequate quantities of fuel oil at a very reasonable cost. It is fitting therefore to pay a tribute to the oil companies for the way in which our liquid fuel supplies were maintained at reasonable cost through the war. The relative costs of heat units in contractors' firewood and in oil reached parity early in the war years and there has actually been a marked change-over to imported fuel during this time. The coal supply, owing to transport and world shortage, has been very difficult, and oil is becoming, or has become, the tea industry's principal source of heat apart from home grown firewood. The cost of home grown firewood being intimately bound up with labour and transport cost has also risen and is unlikely to revert to former levels or to increase in availability. The low costs of construction and upkeep of a D. F. Heater, coupled with a high efficiency which ensures very economical use of liquid fuel, therefore makes *Direct Firing* worth careful consideration under present conditions.

At the beginning of 1945 a D. F. heater was installed in St. Coombs factory in parallel with a tubular stove of high thermal efficiency in such a way that accurate comparison could be made between the two alternative methods of heating the air supply for a common drying chamber. A number of carefully controlled tests were carried out, after which the D.F. heater was put into daily use on the commercial side of the factory, operated by ordinary factory labour, and supervised by the tea-maker.

TESTS

The results of comparable tests on the two different types of heater are shewn in Table I. The heaters were, as already mentioned, both connected to the same drying chamber. In referring to Table I the following points should be noted :—

1. *Time taken to raise temperature.*—The test results shew the times for the thermometers to reach 190°F. In actual practice, when the direct-fired heater is in use, leaf can be charged into the machine five or ten minutes after lighting up, as it takes 20 minutes to fill the drying chamber and the duty is therefore light for the first 20 minutes. When the indirect heater, *i.e.*, the tubular stove, is in use, again it is not necessary to wait until the exact working temperature is reached, but since the large amount of metal in the tubular stove has to be raised to working temperature, the temperature of the air drawn over it rises slowly and must be closely approaching the working degree before the feeding of leaf is commenced. In the case of the direct-fired heater, the air is at working temperature almost at once but it takes sometime for the drying chamber, and therefore the

inlet thermometer, to record the working temperature. There is no capital of heat locked up in a D.F. heater as there in a tubular stove.

2. *Total weight of leaf fired and moisture content of fermented leaf.*—It will be noted that both from the duration of the test and the moisture to be evaporated per pound of tea fired, conditions were slightly in favour of the tubular heater.

3. *Made Tea.*—The leaf fired per gallon of fuel used would therefore, as pointed out in para 2, have been even higher in the case of the D.F. heater had the moisture content of the fermented leaf been exactly equal in the two tests.

4. *Fuel used.*—The most exact comparison may be made on the oil consumption figures, especially in the hot air tests. It will be noted that both heaters were heating the same amount of air (Datum 24) to the same temperature (Data 10 and 11) over the same temperature range. They were both performing practically exactly equal tasks but one was consuming 3.3 gallons of fuel per hour and the other 4.5 gallons per hour (Datum 21). The consumption rate was steady but in the tubular heater some of the heat is unavoidably lost in the flue gases which pass up the chimney. The particular tubular heater used in these tests is of comparatively high thermal efficiency. The air from the tubular heater is to a slight extent drier than the air from the D. F. heater which contains the water of combustion* of the fuel, which at 3.3 gallons consumption of oil per hour means the formation of approximately 34.4 lb. of water. During the tests in which leaf was dried, 157 lb. of water per hour were evaporated by the D.F. heater as against 143 by the

TABLE I

		DIRECT HEATING		INDIRECT HEATING	
		Hot air only	With leaf	Hot air only	With leaf
1. Time to raise temperature	...	25 min.	25 min.	60 min.	45 min.
2a. Duration of test after raising temperature	...	420 "	480 "	360 "	231 "
2b. Total time of feeding or discharging	...	—	460 "	—	211 "
3. Total duration of test	...	445 "	505 "	420 "	276 "
Fuel used					
4. To raise temperature	...	1.7 gals.	1.25 gals.	4.25 gals.	4.0 gals.
5. For duration of test after raising temperature	...	23.3 "	27.00 "	26.75 "	16.25 "
6. For total duration of test	...	25.0 "	28.25 "	31.00 "	20.25 "
Firing					
7. Total wt. of fermented leaf	...	—	2501 lb.	—	1150 lb.
8. " " made tea	...	—	1297 "	—	648 "
9. " " moisture evaporated	—	—	1204 "	—	502 "
Mean Temperature °F					
10. Air intake (outside air)	...	79°	78°	74°	73°
11. Inlet	...	192°	192°	191°	191°
12. Exhaust	...	—	128°	—	131°
Mean percentage moisture contents					
13. Withered leaf	...	—	53	—	53
14. Fermented leaf	...	—	49	—	44
15. Made tea	...	—	3.1	—	3.8
AVERAGES					
16. Fermented leaf fed per hour	...	—	326 lb.	—	327 lb.
17. Made tea discharged per hour	...	—	169 "	—	184 "
17. " " per gallon of fuel :—					
(a) Excluding amount to raise temperature	...	—	48 "	—	40 "
(b) Including amount to raise temperature	...	—	46 "	—	32 "
19. Moisture evaporated per hour	...	—	157 "	—	143 "
20. " " per gallon of fuel :—					
(a) Excluding amount to raise temperature	...	—	45 "	—	31 "
(b) Including amount to raise temperature	...	—	43 "	—	25 "
21. Fuel used per hour excluding amount to raise temperature	...	3.3 gals.	3.4 gals.	4.5 gals.	4.2 gals.
22. Fuel used per hour including amount to raise temperature	...	3.4 "	3.4 "	4.4 "	4.4 "
Miscellaneous Data					
23. Fan speed r.p.m.	...	590	590	590	590
24. Volume of air at exhaust in cubic ft. per min. (cold air reading)	...	5985	—	6090	—

(Fan valve adjusted to give constant volume of air-flow in all tests)

Indirect method (Datum 19), the fuel consumption in one case being 3.4 gallons and in the other 4.2 gallons. On the basis of equal moisture evaporation, therefore, the ratio is 3.4 to 4.6 and so for all practical purposes the moisture of combustion is negligible in its effect on drying capacity, as the ratio of fuel consumption is practically the same in both tests. The air leaving a tea dryer is still far from saturation point with respect to moisture, and this is the reason for the negligible effect of the moisture of combustion on the drying capacity of the air in a D.F. heater.

COMMERCIAL OPERATION OF D. F. HEATER

The D.F. heater installed in St. Coombs factory has been in daily use for almost a year. It has been operated and maintained by ordinary factory labour and supervised by the tea maker. Through the courtesy of Mr. R. C. Scott we have also been afforded every facility for examining the installation at Ottery Estate and the records of its use. We are from this experience satisfied that a Direct Fired heater is a practical proposition and suitable for use under ordinary estate conditions.

We are, however, bound to point out that since, in the D.F. heater the products of combustion are drawn through the leaf in the drying chamber, it is *possible* to taint leaf more easily than it is in a tubular heater. In the first place, the heater must be properly designed and constructed. The Shell Co. of Ceylon should be consulted in this matter. Secondly, the oil burning equipment must be suitable for the purpose for which it is employed and properly installed. Some types of oil burner are *not* suitable for direct fired heaters and responsible and efficient opinion must be sought on this matter. There are also several tech-

nical safeguards which must be incorporated in the installation.

Under the conditions specified, little short of gross neglect can lead to any mishap, but it must be realised that against this personal factor of gross negligence there is at the moment no possible technical safeguard. Mechanical troubles are bound to occur from time to time and taints arising from such troubles are largely safeguarded against by a cutout device which shuts off the oil supply as soon as the atomising air supply fails. A fall in atomising air pressure due to partial failure (for instance severe belt slip) would be indicated by the pressure gauge. If by any unfortunate combination of circumstances a smoky flame results from mechanical defect, it should be obvious to any normal labourer and immediate steps may be taken to minimize the effect by isolating the leaf in the machine at the time, and by getting tea tasters' advice before bulking the leaf with the rest of the teas fired. Only the grossest neglect could lead to a D.F. heater being operated with a smoky flame for sufficient time to taint any considerable quantity of tea. However, in the past, furnaces fed with firewood have fairly commonly been neglected and maltreated and it is necessary to make it perfectly clear to estate staffs that if a D.F. heater is installed, reasonable interest must be taken in care and maintenance. Technical knowledge is not required but merely a modicum of common-sense and awareness.

In seven years at Ottery Estate and one year at St. Coombs there has not been a pound of tea spoiled by commercial operation of D.F. heaters, and there is no reason why the heaters should not be installed in any factory where supervision is normal.

SPECIAL NOTES ON OPERATION

The normal sulphur content of liquid fuel makes it necessary to specify certain conditions for operation which should be recorded and displayed prominently for the benefit of the factory labour concerned with the operation of a D.F. heater. The sulphur in liquid fuel, which amounts to about 0.9 per cent of its weight, burns to sulphur dioxide which is a pungent gas familiar to all who strike Ceylon matches. It is also alleged to be a prominent constituent of the vapours of the lower world. Sulphur dioxide gas is used at comparatively high concentration for preserving dried fruits and especially concentrated fruit drinks, such as passion fruit juice. The concentration in the air blown through the dryer is very low and its effect on tea leaf negligible. The presence of sulphur dioxide in the withering lofts, especially if a D.F. heater is being used for withering, may cause comment but it is quite harmless. The effect of sulphur dioxide on the ironwork of the dryer is *not*, however, entirely negligible.

Sulphur dioxide attacks iron vigorously at very high temperatures, the rate diminishing with temperature and become slow at tea dryer furnace temperatures. At 190°F. the rate of attack is negligible but below 140°F. it again increases and may eventually have undesirable indirect effects on the fired tea. The actual amount of iron attacked is very small indeed but the product of the attack, namely ferric sulphate, may find its way into the leaf and cause occasional trouble with very dark liquors. Particles of ferric sulphate become detached from the iron-work, and if included in dry leaf when cupped out will give an almost black

liquor. This trouble is not of any very great importance and may be entirely avoided by running the dryer above 140°F. As a matter of fact considerable corrosion also occurs in tubular heaters through running them below 140°F. for withering.

It should therefore be an invariable rule in every tea factory never to operate any machine for withering at an inlet temperature below 140°F. In the case of a D.F. heater written instructions in English and Tamil should be attached to the heater and the dryer. Recording thermometers are very useful for ensuring that this rule is obeyed. The first sign of a breach of this rule is a sticky deposit on the trays of the dryer and if this is noted at any time the drying chamber should be cleaned out.

In remote parts of the factory where condensation is liable to form in wet weather, unprotected, *i.e.*, ungalvanised or unpainted iron may "grow" white "whiskers" of ferric sulphate but it is not considered to be of any practical importance and will probably pass unnoticed in most cases.

SUMMARY AND CONCLUSIONS

1. Direct-Fired heaters have been found to have the following advantages :—
 - (a) Relatively low cost of construction.
 - (b) A very low cost of maintenance compared to tubular stoves.
 - (c) A high efficiency resulting in a 25 per cent saving of liquid fuel on a 3 ft. dryer in comparison to a tubular stove of high efficiency.
2. They have been found reliable in operation and easily maintained and supervised by an ordinary factory staff.

3 The following precautions are essential :—

A D.F. heater installation must be :—

- (a) Properly designed and installed by a responsible engineering firm in consultation with the Shell Co. of Ceylon.
- (b) Carefully supervised by a tea-maker who takes an interest in his job and who is reasonably alert. No special technical knowledge but only common-sense is required.

The estate superintendent should also satisfy himself that the installation is properly maintained. It is emphasised that the gross negligence often allowed with firewood cannot be tolerated with a D. F. heater.

- (c) Even when withering, the temperature of the air passing through and out of the drying chamber must be maintained above 140°F.

STUDIES OF SHOT-HOLE BORER OF TEA

1—DISTRIBUTION AND NOMENCLATURE

C. H. GADD

DISTRIBUTION

Occurrence in Ceylon.—The shot-hole borer beetle (*Xyleborus fornicatus*) was first noted as a pest of tea in Ceylon by Mr. G. Alston of Craighead estate, Nawala-pitiya, in 1892; possibly the beetle had then been on the estate for a few years, more or less unobserved. In 1893, *vide* Green (1903), the infested tea area amounted to 500 acres only, but by 1903 the estimated acreage had become 50,000 acres, the pest having extended its range to surrounding districts.

In 1912 the borer was proclaimed a pest within the meaning of Ordinance No. 6 of 1907, and it became compulsory for its presence on any plantation to be reported to the Director of Agriculture. Speyer, in 1918, published the names of all estates and districts from which the beetle had then been reported. The list of infested estates at the Department of Agriculture, no doubt, has grown considerably since

then. It should be noted, however, that the presence of a name on that list does not mean that the beetle is a *pest* on that estate; it merely records that at sometime or other the beetles or their galleries have been seen there. For instance, St. Coombs estate does not appear on Speyer's list, but since its publication, beetle galleries have been observed on that estate and their presence reported to the Department. Still the beetle has not become a pest, and damage caused by it, if any, is negligible. A few galleries may be found when pruning, though rarely are living beetles found within them.

Of more interest than Speyer's list of infested estates are his observations on the distribution of the beetle. He summarised the position as follows :—

"The elevation of the Craighead estate is about 2,000 feet above sea level. It is at this elevation that shot-hole borer is now

particularly abundant.... There does not seem to be much doubt that shot-hole borer spreads gradually upwards attaining an altitude of 5,000 feet, but it becomes less common when 4,000 feet is reached, and above 4,500 feet it is no longer a serious pest.... At very low elevations, 100-1,000 feet, the insect curiously enough becomes again less abundant."

In the writer's opinion the above statement fairly represents the position today also. In other words, the beetle has not materially extended its range as a pest since 1918.

From time to time reports are received of the presence of the beetle on estates normally considered to be entirely free of the pest. This sometimes gives rise to the view that the beetle is "moving up the hill," and the prognostication at times creates a little alarm. The beetle undoubtedly moves "up the hill," but experience has shown that the move is only temporary. In 1918, Speyer wrote "Inquiries show that Shot-hole borer was found attacking half-an-acre of tea on the Glasgow boundary in August, 1903; the infected portion was pruned and all the prunings were burnt; this information comes from Mr. Jackson who was then Superintendent on the estate. The borer has not re-appeared here or on any neighbouring estate in the Dimbula district."

The final statement as it stands is not quite accurate at the present time, as several estates in Dimbula, *e.g.*, St. Coombs mentioned earlier, have at sometime or other reported the presence of the beetle, but if the words "established itself" were substituted for 're-appeared' the statement would be as true today as in 1918.

Again, he wrote: "The most interesting point is the limitation of the distribution at certain places in well-marked valleys. In Dimbula the infestation comes to a somewhat abrupt end on the East Holyrood and St. Andrew's estates, and it seems likely that the insect is from time to time blown from the lower portion of the valley (Medde-crombra) to the latter estate, but never becomes properly established there." The distribution of the beetle is still limited by elevation exactly as in 1918, as the beetles do not breed normally and increase numerically at altitudes above 4,000 feet or near sea level in Ceylon. The controlling factor is in some way connected with altitude and, as a guess, one might name temperature to be the important factor, the higher elevations being too cold and the lower too warm: but there is no direct experimental evidence to support that guess.

The beetle is also known to occur in South Indian tea areas, but there it has never attracted any great attention as a pest. In 1937 Rao stated: "Evidence is lacking as to whether there has been any definite and progressive increase in the infestation from year to year since its first appearance. There is evidence, however, to show that the pest does not exist on all fields of an estate but is yet confined to odd fields and even there only to certain patches." Since then no marked increase of the pest has been reported.

The mere bringing together of tea bushes and tea shot-hole borer beetles does not necessarily result in the beetle becoming a serious pest. Other conditions, which include climate, must also fulfil certain requirements of the beetle satisfactorily. Although it may not be possible to define those conditions accurately, it is evident

that through the greater part of the tea area in South India and at high and low elevations in Ceylon, the accessory conditions are not such that allow the beetle to establish itself and breed freely. Hence the beetle does not and cannot become a pest of major importance there, except when such conditions become temporarily favourable, or until a race of beetle which can accommodate itself to those conditions is evolved.

The distribution of Shot-hole borer as a pest of tea in Ceylon has not altered appreciably for many years. The borer appears to have established itself as a pest in all tea districts in which it can survive and multiply, and experience shows that the risk of the beetle establishing itself as a pest in new districts or in fields previously free of it is negligible. If that view is accepted, it will be evident that elaborate precautions to prevent further spread are unnecessary and unwarranted. Existing regulations restricting the movement of tea plants from any area, whether infested or not, without the Director of Agriculture's written permit serve no useful purpose and should therefore be rescinded.

World Distribution.—Reviewing the records of occurrence of the beetle, Speyer (1918) concluded that the only records of the insect outside Ceylon were of a collection made at Bangalore, India, from a castor-oil tree, and possibly Hagedorn's record (1913) from Penang, of the nutmeg tree as host.

Beeson (1925) has since shown that *Xyleborus fornicatus* is indigenous in India and given records from Bengal, Madras and Mysore. Tea, however, was not included in his list of Indian food plants as some doubt existed concerning its presence in South Indian tea. Bainbrigge Fletcher

(1914) had reported the presence of the borer in tea in Travancore in 1914 on information supplied by Anstead, who had observed it in 1910. Later, Anstead came to the conclusion that he had been mistaken and stated (1920) that *X. fornicatus* did not appear to occur in South India. In view of Rao's observations (1936) there can be no doubt that *Xyleborus fornicatus* does now occur in South India in tea, and that it has existed there for some years. Probably Anstead's original observation was correct.

The beetle is also known to occur in the Dutch East Indies (Van Heurn 1919; Kalshoven 1924 a and b) in Hevea and Tea; and in Northern Formosa (Sonan 1939) in Tea. Only in Ceylon does the pest appear to be of serious importance.

HOST PLANTS

Green (1903) pointed out that the borer beetle did not confine itself to tea, and that it could be found in other plants. He listed *Albizia stipulata*, *A. moluccana*, *Bixa orellana* (Annatto), *Cinchona calisaya*, *Erythrina lithosperma* (Dadap), *Grevillea robusta*, *Lantana*, *Psidium guyava* (Guava), *Ricinus communis* (Castor oil) and *Theobroma cacao* (Cocoa) as hosts in Ceylon. In 1905 he added *Crotalaria striata* to the list. Rutherford (1914 a and b) added *Hevea brasiliensis* (Rubber), *Melastoma malabathricum*, *Persia gratissima* (Avocado Pear), *Photinia japonica* (Loquat) and *Tephrosia candida*. He mentions having seen also cases of invasion of *Poinciana regia*, *Bauhinia* sp., and *Aberia gardneri* when growing in proximity to infested tea; in *Poinciana* and *Aberia* the beetles were usually entombed in exudations of resin, whereas in *Bauhinia* the beetle made no headway. Speyer (1918) published a complete list

which in addition to plants already mentioned included *Allophylus cobbe*, *Caryota urens* (Kitul), *Cassia alata*, *Citrus aurantium* (Orange), *Clerodendron* sp., *Desmodium cephalotes*, *Petraea volubilis*, *Tephrosia vogelii* and *Terminalia catappa* (country almond). Since then a few more names have been added to the list, namely *Cedrela toona* (Jepson 1920) *Gliricidia sepium* (Light 1927) *Derris robusta* (Light 1928) and *Crotalaria anagyroides* (Hutson 1932).

Outside Ceylon the following additional plants have also been recorded as hosts:—*Myristica fragrans* (Nutmeg) in Penang, *Albizzia odoratissima*, *Erythrina indica*, *Ixora parviflora*, *Odina Wödier*, *Gmelina arborea* and *Ficus nervosa* by Beeson (1930) in India; and *Schleichera trijuga* by van Hall (1920) in the Dutch East Indies.

The above list of plants in which *Xyleborus fornicatus* has been found at some time or other may appear impressive and suggest that there are numerous possible sources of infection for tea. The truth is probably very different. The fact that the beetle may be found in particular plants is no proof that they can live normally and multiply in those hosts. Mention has already been made of Rutherford's observation that in *Poinciana* and *Aberia* the beetles usually became entombed in resin. In 1903, Green expressed the opinion that the insect is not at home in *Grevillea* and attacks only sickly branches; the beetle is still found at times in *Grevillea* branches but there appears no reason for any modification of Green's opinion. Speyer said of the plants listed by him in 1917 that only three harbour the insect to any great extent, namely castor oil tree, tea and country almond, if the identification is correct in the latter case.

In India, *vide* Beeson (1930) "The principal food plant is *Ricinus communis*," i.e., castor oil. In Ceylon it is now undoubtedly tea, though in Speyer's opinion the true host plant of the beetle is the castor oil plant (*Ricinus communis*) (Director of Agriculture 1916).

Tea and Castor-oil Tree.—As a result of Speyer's opinion that the castor oil tree is the true host of the beetle *Xyleborus fornicatus* and of his observation that the beetle swarmed from castor to tea, it was decided that no measures for the control of the borer could be successful so long as castor existed in the tea area (Director of Agriculture 1915). The growing of the castor oil plant within the tea-growing area of Ceylon was prohibited by law in June, 1916. Time has shown this to be an unnecessary restriction. Yet it still exists. It is evident, however, that the failure to control beetle damage in tea cannot be attributed to reinfestation from castor.

Jepson (1920) started experiments using castor as a trap tree. He appears to have experienced considerable difficulty in growing castor amongst tea, not because of the beetles but because of other troubles. The experiments were discontinued in 1923 as they failed to indicate any reduction in numbers of the shot-hole borer beetle in the areas interplanted with castor (Jepson 1924).

Later, the question arose whether the castor beetle is really the same as that which invades tea. Observations on this question will be discussed in a later section.

NOMENCLATURE

The Beetle.—*Xyleborus fornicatus* was originally described and named by Eichhoff in 1868 from a specimen collected in Ceylon. The plant from which the beetle was taken is unknown. It may have

been tea, but there is considerable doubt about it. Whether the plant was castor is equally unknown.

What is generally considered to be the oldest field of tea under continuous cultivation in Ceylon is a 20-acre block on Loolécondera Estate, Hewaheta, which was cleared for planting towards the end of 1867 (Ukers 1935). There were at that time a few tea bushes in the Botanic Gardens, Peradeniya, in Nuwara Eliya and in a few other places. So it is not impossible that Eichhoff's specimen came from tea, but there is doubt about it.

The earliest known authentic specimens from tea were sent to the Indian Museum in 1895 (Barlow 1896) and they were examined and identified by Blandford as *Xyleborus fornicatus* (Eichhoff).

In 1903 Green published a short description of the tea shot-hole borer and used the name *Xyleborus fornicatus* in connection with it. His description is reproduced below :—

"The insect . . . is a minute cylindrical beetle, 2.25 millimetres (or a little more than one-twelfth-of-an-inch) long. It belongs to the family *Scolytidae*, and is known to Entomologists by the name of *Xyleborus fornicatus*. The mature beetle is of a black or very dark brown colour. Individuals that have recently emerged from the pupal condition are of much paler tint but after some hours the full colour is assumed. The head is almost concealed beneath the anterior part of the thorax, which is rounded in front and projects like a hood. The round part of the thorax is roughened like a rasp, and is probably employed as such in the excavation of the galleries formed by the insect in hard wood. The abdomen is completely covered by the elytra or wing

cases, which are minutely pitted in longitudinal lines and sparsely covered with fine erect hairs. The wings are well developed and capable of carrying the insect through the air in search of fresh breeding grounds in the neighbourhood. When not in use they are neatly folded away and concealed beneath the hard wing cases."

"The adult male is a still smaller insect, measuring only 1.50 millimetres, equal to exactly one-seventeenth of an inch in length. It is usually of a paler colour than the female, but of the same outer form. It has, however, no wings beneath its wing cases, and lives and dies within the galleries in which it has been reared. The work of excavation is probably carried on entirely by the adult female insect."

Its name.—In 1922 Eggers, an authority on the *Scolytidae* stated that he had examined specimens from Peradeniya, and that, although they agreed with Green's description they did not match Eichhoff's type, then in his (Eggers) possession. He therefore described the specimens from tea as a new species which he named *Xyleborus fornicatior*.

Winn Sampson, in 1923, gave reasons for being unable to accept *X. fornicatior* (Eggers) as a valid species. Beeson (1925) supported Winn Sampson in so far that *X. fornicatior* could not be accepted as a good morphological species, but he considered the retention of the name in sub-specific rank to be desirable on biological evidence.

Speyer (1919, 1923) recognised two races of *X. fornicatus* in Ceylon which could be distinguished by their size. The larger type predominates in castor and dadap, and the smaller in tea. These two types correspond to the sub-species *X. fornicatus fornicatus* with a body length of 2.5 mm.

and *X. fornicatus fornicator* with body length of 2.2.—2.35mm. Beeson also recognises *fornicator* not only by size but by the elytral curve, from scutellum to sutural apex, being more convex than in the larger *fornicatus*, which has the basal third of the elytra more or less flat and horizontal.

The elytral curvature is by no means a satisfactory character to work with; size is much better as it allows of accurate measurement. In Table I the measurements of five samples of *X. fornicatus* are summarised. Each sample consisted of 50 female beetles removed from galleries in castor, tea and *Mimosa bracaatinga* bran-

If, however, we attempt to classify individual beetles by their size, the problem becomes still more difficult. It may be seen from the range of measurements given in Table I that the largest specimens from Tea A and *Mimosa* are larger than the smallest specimens from Castor. If the 50 beetles from Tea A or *Mimosa* were mixed with the 50 from castor it would be impossible to separate them again into the two original groups either by size or any other character.

Speyer's explanation (1923) of this type of observation is that "the larger race in castor, (i.e., *fornicatus-fornicatus*) gives rise

TABLE I

Summary of Length Measurements of 5 samples, each of 50 female *X. fornicatus* from different hosts.

		Range mm.	Mean mm.
Tea A (25 months from pruning)	...	2.2—2.4	2.33
<i>Mimosa bracaatinga</i>	...	2.2—2.4	2.34
Tea B (20 months from pruning)	...	2.3—2.5	2.39
Tea C (24 months from pruning)	...	2.3—2.5	2.39
Castor	...	2.3—2.6	2.45

(The mean values 2.34, 2.39 and 2.45 mm. are all significantly different).

ches. The three samples from tea were collected at different times and from different fields of one estate. The castor and *Mimosa* specimens were obtained from the same locality. The mean length of the specimens from castor was 2.45 mm., which immediately places them as belonging to the large type, *fornicatus*. The specimens from Tea (A) and *Mimosa* have mean lengths of 2.33 and 2.34mm., respectively, which show them to be of the smaller type *fornicator*. But the specimens from tea (B and C) both have intermediate values, viz. 2.39 mm. As judged by size they are neither *fornicatus* nor *fornicator*.

to the small race in other plants, and that this small race, (i.e., *fornicatus fornicator*) is gradually predominating over the original one in Ceylon."

Speyer's earlier explanation (1919) was different. He then wrote "It would seem that, when the beetle has bred in castor for sometime, a distinct 'race,' but not a distinct 'species,' of slightly larger size than the insect usually found in tea, is evolved. The same applies to Dadap. At least one outbreak of this larger race has occurred in tea." The known fact, viz. that a large and a small race occur, will fit one explanation as well as the other, but if the castor race

evolved from the tea race, his own hypothesis that the castor oil tree was a main source of infection for tea is nullified. His later explanation better fits that hypothesis.

The measurements (2.25 mm. for the female) given by Green in 1903 show that the beetle he was acquainted with was the small one, *fornicatior*. As the growing of castor in the neighbourhood of tea has long been forbidden, and consequently the infestation of tea by the larger beetle has long since ceased, the presence of intermediate sized beetles (Tea B and C in Table I) cannot be regarded as a stage in the evolution of the smaller type. It may here be stated that the probability of the intermediate type being a cross between *fornicatus* and *fornicatior* is extremely unlikely, because so far as is known mating takes place in the parent gallery and the male cannot fly.

In South India where the beetle has not become a major pest of tea, Rao's observations indicate that there too beetles occur in tea which cannot readily be classified as either *fornicatus* or *fornicatior*, but are intermediate in character. In his annual report for 1940-41 Rao states :—

"Through the courtesy of Dr. Beeson... an examination was possible of a series of beetles collected from estates near Vandiperiyar over a period of several years. The examination revealed that the majority of the specimens showed a mixture of features of *fornicatus* and *fornicatior*. The typical *fornicatus* features were possessed by a small number of individuals while the number of individuals conforming to the *fornicatior* type was equally small.

"The specimens of the beetles were all collected from tea bushes at different times and there could be little doubt that the beetle had bred in them for a number of

generations. From the above examination it would appear that the insect even after several years' breeding in tea (ten years as far as authentic records go and probably many more than this), has not produced a race which is exclusively *fornicatior*."

So far, comparisons between *fornicatus* and *fornicatior* have been made on morphological characters, and if we are to draw a conclusion at this stage it must be to support Winn Sampson's opinion that *X. forniciatior* Eggers cannot be accepted as a valid species. Beeson, however, suggested the retention of the name with sub-species status on biological grounds. He clearly stated those grounds in a letter to Mr. F. P. Jepson in 1934. In it he said :—

"I have collected *fornicatus-fornicatus* Eich in many parts of India in the vicinity of tea gardens, but have never found a case of attack on tea. Here in Dehra Dun, the borer is abundant in castor oil but never spreads to tea a few hundred yards away. I have seen no specimen from Ceylon of *fornicatus-fornicatus*, that are labelled 'ex-tea,' all the tea specimens being *fornicatior*. I must admit that I have not tried to force *fornicatus* to attack tea."

Jepson himself had recorded (1920) a somewhat similar observation of the castor beetle not moving to tea. He wrote : "In April, an unusually severe infestation of castor by Shot-hole Borer was discovered in the Rakwana district, literally thousands, if not hundreds of thousands, of galleries occurring in a few plants. It was significant that the surrounding tea was comparatively free from attack."

King (1940) supported Beeson's views but on different grounds — not that the beetle from castor does not attack tea, but that the beetle from tea does not attack castor. He stated : "On biological grounds

the distinction is quite clear, since the tea borer does not attack castor; and while the castor borer may attack tea to a slight extent it only does so in the vicinity of attacked castor plants."

King's statement was based on the results of cross inoculation experiments (King 1941). His results showed that the beetle from tea could breed in two test plants, tea and *Mimosa bracaatinga*, whereas the beetle from castor could breed in at least five hosts in addition to castor. They are *Albizzia falcata*, *Hevea*, *Mimosa bracaatinga*, *Tephrosia candida* and Tea. Both beetles, (i.e., from tea and castor) were able to bore galleries in several other plants but were unsuccessful in breeding in them.

Later, King had reasons to doubt the accuracy of his statement concerning the inability of the tea beetle to attack castor. He discovered (King 1941) that castor is not susceptible to borer attack until the tree is at least two years old, and he therefore decided to repeat the experiment with castor of suitable age. This experiment (Gadd 1942) showed that the tea borer beetles entered the castor branches, and of 19 galleries dissected 5 were found to contain 33 inmates consisting of eggs, larvae, pupae and adults.

King's cross inoculation experiments clearly demonstrate that, at least in Ceylon, the borer from tea will attack castor just as the beetle from castor will attack tea. Unfortunately no measurements were made of the beetles used and obtained in these experiments. It would have been of great interest to know whether the offspring of larger beetle from castor were smaller when raised in tea, and *vice-versa*, as little or nothing is known of the effect of the host on this parasite.

Although the inoculation experiments lend support to Speyer's view that the

castor beetle will pass from castor to tea they afford no explanation of Beeson's observations, at Dehra Dun, India, where the beetle never spreads to tea. The experiments are not sufficiently conclusive to establish the biologic identity of the beetles normally found in castor and in tea. More information is required, not only of the effect of the host on the size of the parasite but of the life history and habits of both beetles. The borer from tea, as a pest, has been the subject of study for many years but the castor beetle has not been similarly studied. The writer is of the opinion that a comparative study of the two insects might disclose important differences.

Recently I had the opportunity of observing an infested castor stem. The males behaved in a manner quite different from those from tea branches. A discussion of this behaviour will, however, be reserved for a later section, as the observations are not yet completed. It will be sufficient here to state that biological differences between the beetles probably exist, and that in consequence there may be some justification for the retention of the two sub-specific names as Beeson suggested.

Strictly, the name *Xyleborus fornicatus fornicatior* should be used only for the beetles as defined by Beeson, i.e., for the smaller race with the more arched back. Like other writers I have used the name *fornicatior* to denote the beetle from tea. Such use is not strictly correct as a small number of beetles from tea, as stated by Beeson, exhibit *fornicatus* features, and an equally small number are typically *fornicatior*. The majority are indeterminate. In later articles the writer will use the name *Xyleborus fornicatus ex-tea*, as that designation carries no implication that only the smaller type with *fornicatior* characters is intended.

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TEA PRUNING-CYCLE PATTERNS

T. EDEN

The length of a pruning-cycle is commonly determined by rough and ready methods. It is generally recognised that there are a goodly number of factors involved, of which jat and elevation are the chief. Sometimes it is asserted that manuring has a marked influence. Apart from any or all of these, there are factors of convenience. A bush on a long pruning-cycle may become unmanageable in plucking, and the increased cost of pruning, coupled with the longer interval after pruning during which the bush is out of plucking, may decrease the apparent advantage to be gained by an extended cycle. Surveying the past decade, it is probably correct to say that there was, until the war brought about symptoms of labour shortage, a tendency to increase the length of pruning-cycles. There is satisfactory evidence that the quality of tea improves for a time after recovery from pruning, gradually approaching a maximum which remains reasonably constant under specific circumstances. Recent work on Shot-hole borer suggests that lengthened pruning-cycles may be a practicable method of combating the damage due to this pest.

For some years, as opportunities have occurred, we have collected data from estates about the behaviour of tea with pruning-cycles of varying lengths, particularly of cycles of four and five years. Out of a considerable number examined most have had to be discarded because of some vitiating irregularity in the records. Estates with a ten to fifteen years' uninterrupted sequence are scarce, but a number of interesting observations have been made. The time is not ripe for any simple generalisation: the purpose of this article is to put

on record a sample of the observations made, and to solicit help in extending them by obtaining access to suitable data at present unknown to us.

The first indication of the type of difference with which this article is concerned came from one of our own experimental areas. The experiment is in six identical blocks distributed over a forty-two acre field. Whilst five blocks behaved similarly, the sixth was anomalous. Early in the cycle the yield of this block was noticeably below (15 per cent) that of the average of the rest. After three years it was substantially above (25 per cent). The improvement was regular enough to be represented by a simple mathematical relationship.

$$\text{Percentage increase over other blocks} = 1.9 \times \text{Time interval} - 14.7.$$

The time intervals chosen were periods of 45 days. In that period the equation tells us the average improvement of the anomalous block, when compared with the rest, was just under two per cent.

When the yields are plotted for each year of the cycle the result is as in Figure I. Both areas show a low yield in the first year, a maximum in the second and a diminution in the third. What we shall call the pruning-cycle pattern is similar in both, but the change in relative yield during the three years is clearly noticeable. This behaviour has been repeated in three subsequent cycles and suggests that "pruning-cycle pattern" is a definite and stable characteristic of an area or field.

Further instances of the stability of pruning-cycle patterns are afforded by yields graphed in Figure 2 (a) and (b)

from an up-country estate. A, B and C represent the patterns of three out of a total of nine fields of hybrid jat in each of two concurrent pruning-cycles. They show that the maximum yield occurs in the second year, after which there is a more or less steady decline. To have displayed all nine fields on this estate would have confused the diagram, so three rather different patterns have been chosen from among them. The decisive portion of the diagram is the decline from the second year. A has a slightly concave shape; B is convex and C is a straight line. The interesting charac-

average rate of decline from the peak is 128 lb. per annum in the first cycle and 128.5 lb. in the second. These results show a very marked correlation between the behaviour of the individual fields of this estate in successive cycles. The yields in the first year are affected by various considerations, such as time taken to recover from pruning, and they do not maintain the same order of ranking from cycle to cycle. But when the bush has developed to a self-supporting stage with a mature and defined plucking-table, the similarities stand out as follows:—

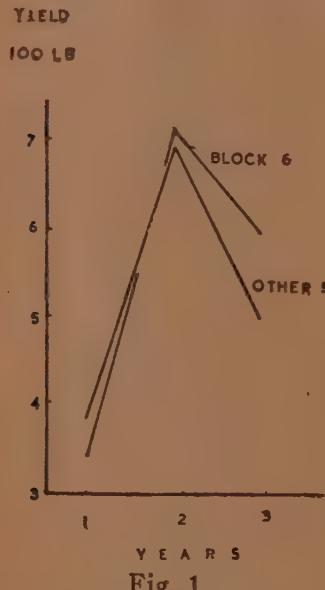


Fig. 1

teristic of these graphs is that the same shapes are repeated with considerable consistency in the second cycle, both in regard to the relative yield levels and to the shapes of the graph. The features of concavity and convexity are not quite so prominent in the second cycle, but they are nevertheless distinguishable. In both these diagrams a third (dotted) line M is shown. This represents the average decline for all nine fields. The slope of this curve is almost identical in both pruning-cycles. The

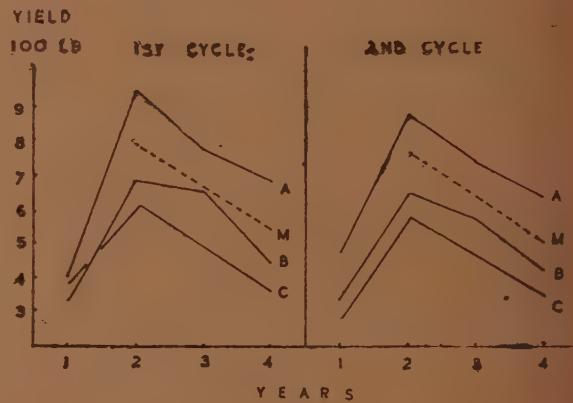


Fig. 2

- (1) The fields maintain the same general pruning-cycle pattern with a peak in the second year.
- (2) The more detailed characteristics of the pattern are maintained from one cycle to the next.
- (3) The average rate of yield decline is identical in the two cycles.

It is highly improbable that such similarity is due to chance. The fact that difference in seasonal weather has not completely deleted the idiosyncrasies of these pruning-cycle patterns, confirms the belief

that such patterns are a stable and enduring feature of individual fields, and to some extent of individual estates.

The observations were extended to the adjoining estate where there was a division similar in elevation and aspect. Six of the eight fields were old plantings of hybrid jat of similar age to the former estate. The remaining two were much younger, and were planted with what would be ordinarily regarded as a better jat, the normal dark-leaved Manipuri that is now commonly raised in Ceylon seed-bearer gardens.

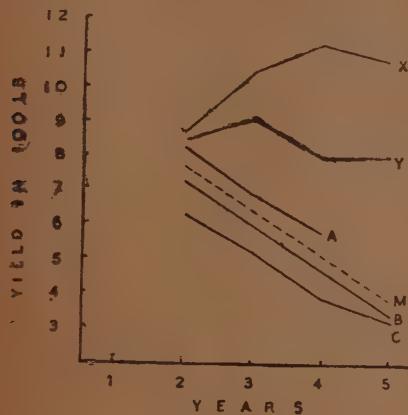


Fig. 3

A selection of the yields of this estate is given in Figure 3. A, B and C show representative fields from the hybrid jat. M as before gives the average of all six fields in this group. X and Y are the graphs of the later plantings with better jat. The yields are plotted from the second year, because, as was remarked in the previous examples, this is the critical period, and because the first portion of the graph is so intricate that the reproduction of the fine interlacing lines would have been very confused.

It is immediately obvious that the fields fall into two groups, of which the one A.B.C. resembles the previous examples, whilst the other X, Y, is of a recognisably different

type. It is of special interest that the slope of the average M for group A.B.C. is, as near as makes no matter, the same as those of the previous averages. It represents a decline of 131 lb. per annum. The fact that these rates of decline do differ by so little as two per cent. from each other is probably a coincidence. Their similarity establishes an identity in type amongst the pruning patterns of these two estates for tea of similar situation and constitution.

In the course of examining such records as have been procurable, examples of both these types of pruning-cycle patterns have been encountered. They will be referred to as the 'early maximum' and the 'late maximum' patterns. There are also what appear to be intermediate stages, as for example fields which attain a maximum in the third year from pruning but drop severely in the fourth. So far, there is one distinguishing feature of these records; the early maximum pattern is found* on old tea of mixed jat, and the late maximum on more recent clearings of better jat. Is either of these characteristics, age or jat, the determining factor for pruning-cycle pattern? At present it is impossible to say. To confirm the hypothesis that young tea starts with the late maximum pattern, and in the course of time deteriorates to the early maximum type, would require a long series of unequivocal records that are not available at present. For the present we shall have to accept the fact without generalizing on the cause.

There is a further point of interest in these pruning-cycle patterns and that is their relation to manurial response. Two of our manurial experiments at St. Coombs are laid down, one on old tea fifty or more years old, and one on younger clearings now in their twenty-fifth year. The patterns of yield are true to the two types described. The experiments have plots with incremental manurial doses, and from

each the response to 40 lb. of nitrogen is obtainable. Figure 4 shows the efficiency of this nitrogen in the various years of the cycle, expressed on an acreage basis as pounds increment of crop per pound of nitrogen. The early maximum type of pattern shows a corresponding early efficiency in nitrogen response, levelling off severely after the maximum cropping year. The other pattern gives a steady increase with no signs of stabilization in the fourth and final year. Since this type of data is

mation for the stability of these types as for the yield patterns; but the probability that the pruning-cycle patterns and the nitrogen efficiency patterns are thus generally associated is an interesting one. In practical terms it suggests the use of different scales of incremental fertilizer dosage within the period of the cycle, for different patterns.

One additional feature of these pruning-cycle patterns is that they show clearly when a field can be profitably run on a long pruning-cycle. Obviously the late maximum pattern is suitable because not only does it not fall away in yield, but in the later periods it responds more efficiently to manuring. The status of the early maximum pattern is not so evident. First-year yields are always low because of recovery from pruning. The fall-off in yield after the maximum may be much less severe than the probable loss occasioned by pruning. But the loss is cumulative and the extension of a cycle by an extra year can only be regarded as satisfactory if the yield in that extended year exceeds the average of the previous years. This is a matter for trial. The fact that pruning-cycle patterns are stable characteristics makes it possible with reasonable accuracy to take a decision on the basis of a one-cycle trial.

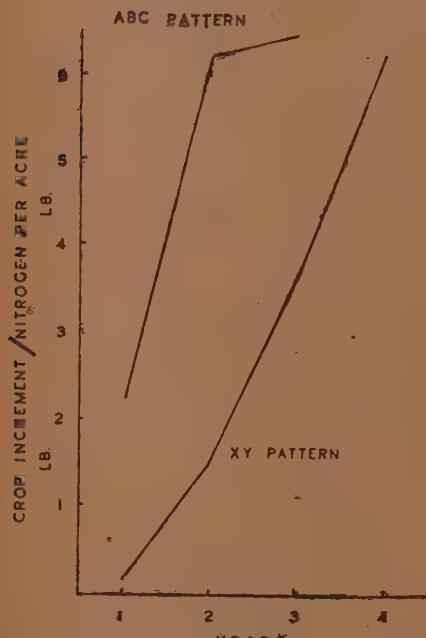


Fig. 4

only obtainable from formal experiments, and cannot be procured from estate records, we cannot obtain the same kind of confir-

In conclusion, we should be glad to hear from estates who are able and willing to supply data on which to extend the type of observation here described. The war has unfortunately interfered with both pruning-cycles and regular manuring, but any information on these lines will be welcome.

TEA SELECTION

I.—THE PRESENT POSITION

F. R. TUBBS

In common with those in other industries, tea planters are turning from pre-occupation with war requirements to the problems of peace. At such a time it is natural to sum up the present position, and to attempt to align future policy to fit the anticipated changes. This attitude of mind has produced a number of enquiries regarding the selection and propagation of improved types of tea bushes. While the Institute has reported the progress of investigations on the subject on numerous occasions, the information has become somewhat scattered. This and succeeding articles are intended to bring together the accumulated knowledge of the subject for easy reference and to provide a list of earlier references in the Institute's publications.

The present position as regards selection and vegetative propagation of tea in Ceylon may be briefly summed up as follows:—

- (i) Selection of individual mother bushes showing desirable characteristics under local conditions has been successfully carried out by the Institute, and also by individual estates who have taken up the work.
- (ii) Propagation of mother bushes by single internode cuttings has been demonstrated to be feasible, not only under the specialised conditions recommended before the war, but also under conditions approximating to those of seedling nurseries, provided due attention is paid to season, shade, watering, and drainage.
- (iii) Ease of propagation of individual selected mother bushes is associated with ease of establishment of the progeny in the field. Relatively poor rooters should therefore be discarded irrespective of their other characteristics. Selection is thus made, not only for yield, *but also for ease of rooting and of establishment in the field.*
- (iv) The yields of clonal plots have shown that field selection of the mother bushes for yield gives, as is to be expected, a few "duds," many good average clones and a few stand-out clones.
- (v) Clones differ in branching habit, and these differences are associated with yield. Free branching types form dense plucking tables and well shaped frames more readily than others, and are thus capable of being brought into bearing much earlier with fewer formative pruning operations.
- (vi) Teas made from different clones display distinct differences in colour and quality, while the rate of fermentation of the leaf during manufacture also varies. Quality above average has been found in high yielders as well as in others; there is no reason to suggest that high-yielding clones gives teas of poor quality.

(vii) Clonal selection opens up the possibility of identifying and propagating bushes which yield better under local adverse conditions of disease or climate.

When the technique of propagation of tea by single-node cuttings was first developed, the conditions required were so specialised that only small numbers of cuttings could be dealt with. Emphasis was, therefore, placed upon the possibilities of improvement by the production of clonal seed-bearers from selected mother bushes. Such a process could be confidently expected to produce considerable improvement in a 'wild' crop such as tea, but is definitely inferior to the production of bearing bushes by the vegetative propagation of desirable types, which would place tea into the same horticultural class as apples and potatoes.

During the war a considerable advance in technique was made that has substantially altered the position. Briefly, it was found possible to root cuttings under conditions approximating to those of an ordinary seedling nursery. This procedure, if it can be successfully adapted to estate conditions, opens up the possibility of using clonal material of definite known character for all planting purposes, instead of heterogenous seedlings from relatively 'wild' bearers.

The crux, as usual, is in the "if." Before any process can be assimilated into planting practice it is necessary that experience of its practical implications and

requirements be obtained. That is the stage we have reached as regards vegetative propagation in Ceylon.

A wave of ill-judged selections, or inadequate trials with single-node cuttings, would only produce an unfortunate and false impression that "there is nothing in selection," or that "internode cuttings do not provide a practical method of propagation on estates." Harm, not good, will result if conclusions are arrived at on insufficient or ill-found grounds, a bad trial being worse than no trial at all. It follows, therefore, that selection and propagation should be confined in the first place to those estates where a keen and interested person is able to devote the necessary amount of regular attention to the work, or where special facilities of personnel, etc., are provided for the purpose. It must be accepted that there will be difficulties and failures encountered in the work; the mere recording of failure is of help to no one, least of all to the estate which has undertaken the work. Only the unremitting interest of keen individuals will observe and correct the faults in local treatment or in method which are lost to those who are able to take only a spasmodic interest in a delegated task. Experience alone will show whether the technique may generally be adopted to estate routine. To illustrate the need for detailed method and constant interest, it may be mentioned that ten minutes' exposure of the leaves of rooting cutting to full sun, by removal of the fern shade while weeding, will cause disaster.

II.—SELECTION OF

The first step in selection work is to assure oneself that there is the time and adequate facilities to enable the work to be not only started, but successfully carried through. This and the succeeding sections will give an indication of what is involved; but it may be emphasised in passing that while the process of selecting mother

MOTHER BUSHES

bushes is amenable to some simplification to fit local conditions, the process of propagating cuttings from them requires very careful attention throughout.

Before deciding upon the method to be employed in selecting mother bushes for propagation and further trial, it is neces-

sary to obtain a clear picture of what is involved. Each bush as it grows in the field is the resultant of its own inherited character and of the local conditions of soil, competition and treatment. The effects of environment are **not** reproduced in clonal progeny grown under different conditions, and are purely local and temporary. Thus, if yield is the character selected for, we are only interested in bushes whose high yield is due to an inherited capacity for growth and not to local favourable conditions. Since it is impossible to distinguish within a single bush differences in yield due to local conditions from those due to inherited vigour, it follows that the selection of a mother bush is necessarily in the nature of a gamble.

In practice, however, the risk of picking a bush whose high yield is due solely to local favourable conditions can be substantially reduced by discarding every bush for whose high yield relative to its neighbours an obvious and physical reason can be adduced. Thus, having selected a bush as superior to its neighbours, it should nevertheless be discarded as a mother bush if it is on a road or drain side, or has vacancies next to it. Thus only a bush having eight normally sized bushes adjacent to it would be considered, unless some special factor intervened. In the accompanying figure the selected bush is shown by O and the presence of other fully grown bushes by X.

X X X
X O X
X X X

Other large bushes, having say one vacancy adjacent, or being situated on the lower side of a path, are likely to be good average bushes by inheritance and stand-out bushes only by the chance of local environment. The question of the "raja-marram" is sometimes raised in this connection. If such a bush was *originally* picked as being noteworthy for its size and vigour when in

normal competition with its neighbours, this fact provides presumptive evidence that it was worth selecting as a mother bush before it had profited from the special treatment such bushes usually receive.

From the above, it is obvious that the *area or field* from which mother bushes are selected is of little importance. In fact where high yield in the presence of a disease or pest is being selected for, it may well be within a relatively poor area of tea that selections are made.

The character for which the mother bush is first selected is yield. Other characters, such as drought resistance, pest resistance, etc. are all, from a practical point of view, diagnosable as high yield under particular conditions.

The second character is ease of propagation by cuttings; with this is usually associated ease of establishment under field conditions. This selection is made when the selected mother bushes are first propagated, and will be dealt with again later; but it should be noted that sufficient high yielding mother trees must be selected to allow of discarding all those subsequently found to be poor rooters.

The method of selection for yield now requires decision; and here again it is necessary to get our fundamental ideas clear beforehand. It has been explained that the inherited and environmental contributions to high yield are superficially indistinguishable, and that selection of the original mother trees is based upon increasing the *chances* of picking bushes whose high yield is due to their inherited constitution. This being the case, there is obviously no point in going to extremes in the process. It is quite unnecessary to test the yield of all the bushes in the field when over 99 per cent of them can be recognised by eye as not being the exceptional yielders for which search is being made. The only

point to be decided, in fact, is how far to carry eye selection.

At one extreme, it would be possible for a superintendent to propagate merely the odd half dozen particularly large bushes of which he was aware, but he would find that many of these were roadside bushes, etc. But if after examination he came to the conclusion that he was aware of a sufficient number of "stand-out" bushes to meet his needs whose superiority could not be attributed to the chance favours of local environment, there is no great point in adopting more elaborate methods, at any rate in the early stages of the work.

To go further than this rather superficial method of selection involves some thought and planning. The method adopted should be such that selection from a large initial population of bushes is carried out, yet the superintendent is only involved in the final examination of a relatively very small number of bushes. The methods described below are capable of wide variation to suit individual conditions, provided the basic principles explained above are not departed from.

The first step is to pick out from an area the biggest bushes, up to about 5 per cent of the total, rejecting all those whose greater size is attributable to local environment as explained above. This process may be conveniently carried out either by pluckers, or by pruners in the case of a field due for pruning. The latter method has the advantages that selection within an old field automatically takes into account the desirable character of good yield at the end of the cycle and also, that the bushes picked out require no labelling, being left unpruned in contrast to the rest of the field.

If this style of selection is carried out over, say, a ten acre area, something between fifteen and twelve hundred bushes will be left unpruned. It will be found that

many of these fail to pass the standards of equal local competition referred to above. This indeed, is to be expected; the average pruner cannot be expected to carry out more than the roughest preliminary selection. This stage of the selection has, however, eliminated 95 per cent of the bushes in the area without any skilled intervention.

Eye selection by some intelligent person other than the superintendent can safely be used on these fifteen hundred bushes to reduce their number to more practical limits. One method is as follows: the person to whose charge this stage of the selection is entrusted proceeds, with a number of pruners, to work through the fifteen hundred bushes, discarding all those bushes whose selection by the pruner has been mistaken and having them pruned forthwith. If at this time all obviously undesirable bushes having 'open' plucking tables with few plucking points, showing a very upright habit of growth, or having poor spread, are pruned, the total number remaining may well be reduced by one-third.

It will be noted in this stage no attempt is made to *compare* bushes, only to discard bushes for whose size there are obvious physical reasons, or whose type renders them plainly undesirable. The reason for this is to delay comparison of the remaining bushes until knowledge of all of them has been gained while discarding the undesirable types.

The next stage, which can with advantage be carried out by the same person, is to work through the thousand or so remaining bushes, pruning out a proportion of the less desirable at every stage, until only the best 250-300 bushes remain.

It is at this stage, when 99 per cent of the bushes in the original ten acres have been discarded, that the superintendent may take more than a supervising interest in the process. Having familiarized him-

self with the bushes by inspecting each as a preliminary he will, by exercise of his experience, and by deliberate and conscious valuation of the relative spread and density of the plucking table, and of the branching habit of the bush, be enabled to reduce the number of bushes considerably, pruning out the rejects as before.

The point which has now to be decided, in the light of local circumstances, is how far the superintendent is prepared to rely solely on his own judgment as to the best yielders among the remaining bushes. He may be prepared to go the whole hog, and pick out by eye alone, say, twenty which he intends to propagate. If he does this, it is desirable to inspect the bushes on several occasions before coming to a final decision: gradually bringing the number down to the final group.

He may, however, decide to reinforce his judgment by actual measurement of yield. Having reduced by eye-selection the two hundred and fifty to the number for which it is convenient to record the yield, the yields are recorded by one or other of the methods described below, and the results used to assist in finally deciding which bushes are to be selected as mother bushes.

Before proceeding to the methods by which yield can be measured, the problem of labelling requires reference. Any form of numbered label or tag is liable to be interfered with, or even moved to other bushes. It is, therefore, necessary to provide some method of checking the identity and location of the individual bushes under record. A plan showing the position of selected bushes, or of bushes whose yield is to be recorded, in relation to drains and paths, is therefore very desirable. The bushes may also be located by collar pruning the second bush away in the row, on either the upper or lower side, as a further precaution against confusion. Mistaken

identity is a risk to be constantly guarded against in selection and propagation work, for by it the fruits of the work may be jeopardized or lost.

Should the decision to record yields be taken, the work necessary is considerably less than was involved in the past. Analysis of the results obtained in the early stages of selection showed that it was unnecessary to record yields for a lengthy period: Eight pluckings may be sufficient to provide an adequate indication of the individual yield capacity of the bushes under examination.

Two methods have been suggested for recording yields — by flush counts and by weighing. These are alternative methods of estimating the production of the bush and the choice between them really depends entirely on the type and amount of assistance available for the work.

The flush counting method consists in recording for each mother bush the number of flush plucked on each occasion, totalling these numbers for each bush at the end of the fourth and eighth pluckings. If the bushes in each of the two series of totals are arranged in order of yield, a small number of the highest yielders may be found standing somewhat apart from, and above, the general range of variation among the remainder. If the same bushes constitute this group in both series, they should be selected for propagation. If not, further series of four pluckings should be made until the same bushes appear constantly as the best yielders to date. It is desirable to bear in mind the actual character of each bush when examining the yields; as differences in the size of flush from different bushes will affect any attempt to evaluate relative yields from the data giving relative flush numbers. This method requires supervision throughout every plucking; and the services of a recorder and pluckers who can, and will, count with fair accuracy.

The weighing or 'bag' method was originally designed to reduce to a minimum the amount of supervision and recording required when yield records were being carried out for much longer periods. The procedure is to have numbered linen or hessian bags, one for each bush under test. Two tapes enable the bag to be tied both at the top and halfway down. Plucked leaf is placed in the upper compartment of the bag and dried in the factory until just before the next plucking. The leaf is shaken down into the bottom half of the bag and the second tape tied before the bag is taken into the field and the process repeated. Thus the dried leaf from each bush accumulates from plucking to plucking, the only strict supervision necessary being to ensure the correspondence of the bag and bush numbers. At the end of eight pluckings the dried leaf is weighed in the factory by the teamaker, or other responsible person, and the result recorded. (*It is important to acquire the permission of the Insurance Company prior to drying the bags in the factory.*)

Finally, it may be again emphasized that the assessment of the yield capacity of the potential mother bush by eye can be carried as far as is desired, having as its extreme the selection as mother bushes of the individual large bushes known from years of experience of the tea on the estate. The reinforcement of eye-selection by actual records of the weight, or number of shoots in the crop, is desirable only to the extent that eye-selection is fallible; and the decision as to at what stage measurement is introduced, if at all, must be that of the superintendent concerned. Further, the selection of mother bushes constitutes nothing more than the selection of the bushes most worthy of further trial and test. Of the bushes thus chosen, a large proportion will later be discarded as poor-rooters and as difficult to establish in the field. It is, therefore, desirable to plan the work with

the aim of picking *not less* than ten mother bushes for propagation at a time.

The subsequent treatment of the selected mother bushes and their propagation will be the subject of further articles.

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Vol. V (1932) pp. 154-156.—A Note on the Vegetative Propagation of Tea.

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Vol. X (1937) pp. 117-123.—The Maintenance of Capital.

Vol. XI (1938).—pp. 8-21.—Nursery Selection pp. 54-66.—Replanting — Tea Selection.

pp. 166-173.—Some Aspects of Tea Selection pp. 212-213.—Propagation of tea by single internode cuttings.

Vol. XII (1939) pp. 38-47.—The Improvement of Planting Material.

pp. 48-49.—Selection for high yields.

p. 50.—Propagation of tea by single internode cuttings in peatmoss.

p. 93.—Review of Conference Proceedings pp. 160-166.—Address to the Ceylon Association in London.

pp. 183-185.—A Note on the Manufacture of Leaf from Selected Bushes.

Vol. XIII (1940), pp. 38-45.—Discussion on Tea Selection and Propagation.

Vol. XIV (1941), pp. 23-30.—The Present position of Tea Selection in Java — Review.

pp. 61-64.—Clone testing in the field.

pp. 98-102.—The Selection of High-yielding Tea Bushes for Vegetative Propagation.

pp. 102-105.—The Technique of Vegetative Propagation of tea.

Vol. XVI (1943), pp. 45-51.—Some Notes on the Selection of High-yielders on Doombagastala, Kotmale.

Vol. XVII (1944), pp. 20-21.—Seedlings and Cuttings.

B.—BULLETINS.

Bull. No. 11, pp. 31-33.—Vegetative Propagation:—

- (a) Layering,
- (b) Stooling,
- (c) Cuttings,
- (d) Division,
- (e) Grafting,
- (f) Inarching,

No. 13, pp. 53-55.—Variability of tea yields.
 No. 18, pp. 51-53.—Selection of high-yielding bushes.
 pp. 53-60.—Propagation.
 No. 19, p. 22.—Selection.
 p. 40.—Variability of tea yields.
 pp. 40-47.—(a) Selection (b) Propagation.
 pp. 74-75.—Miscellaneous factory experiments
 No. 21, pp. 47-52.—Selection :—
 (a) Yield, (b) Quality, (c) Propagation,
 (d) Budding.
 pp. 68.—Selection Experiments.
 No. 22, pp. 63-72.—(a) Propagation of cuttings
 (b) Influence of medium on rooting of cuttings,
 (c) Percentages of rooted cuttings at 2½ months,
 (d) Rooting capacity of green and red wood cuttings from a single bush,
 (e) Effect on rooting of growth-substances and pretreatment,
 (f) Contingency of shooting and rooting,
 (g) Percentages of rooting and callusing (at proximal end) for various media,
 (h) Selection of material for propagation,

(i) Statistics of bushes chosen by selection for yield and quality.
 No. 23, pp. 61-66.—(a) Selection,
 (b) Propagation
 (c) Banji v. growing shoots,
 (e) Effect of nutrients,
 (f) Hormone A.
 (g) Coir dust as a rooting medium,
 (h) Cuttings v. seedlings.
 p. 73.—Manufacture of leaf from field experiments — selection.
 No. 24, pp. 42-45.—(a) Clone tests,
 (a) Transfer to baskets,
 (c) Planting in nursery beds,
 (d) Losses in field.
 p. 52.—Individual bush manufacture.
 No. 25, pp. 46-48.—(a) Clone tests.
 (b) Yields,
 (c) Quality,
 (d) Centering,
 (e) Losses in field.
 No. 26, pp. 52-53.—Tea Fermentation.
 pp. 46-48.—Clones
 pp. 53-54.—Fermentation.
 p. 61.—Manufacture of clonal leaf.

NOTE ON "THE FLOWERING OF THE SO-CALLED DWARF VARIETY OF *ARTEMISIA VULGARIS*"

F. R. TUBBS

The plant which has been regarded as a dwarf variety of the introduced *Artemisia vulgaris* Linn., known in England as Mugwort and in Tamil as *cine mari-kolundu*, has never been definitely identified owing to its non-flowering habit in Ceylon. Before the war various attempts to cause it to flower, and thus to enable its definite identification had been made, including growth under varying conditions and the reduction of the period of illumination to eight hours daily. These failed to produce any effect and the position remained that its identity was presumptive only. A report from the Royal Botanic Gardens at Kew stated that it was different from all the specimens of *Artemisia* from India in their collection.

Mr. M. H. E. Koch, of this Institute, has since made a successful attempt to induce flowering by giving longer periods of illumination than the normal 12-12½ hours' daylight at this latitude.

Six 12-inch pots were previously prepared from ordinary soil mixed with a little cattle manure. Two or three small plants of the dwarf variety were placed in each pot and left in the open till they were established. Before the start of the experiment half-an-oz. of a "complete inorganic" fertilizer was applied to each pot. Five pots were treated with extra light, and one pot was used as a control. Additional illumination was commenced on 8th August, 1945.

The five pots receiving treatment were transferred daily each evening to a plant house, and placed on a stand immediately under 2 electric bulbs each of 200 watts placed 3½ feet above the plants. An eighteen-inch enamelled white shade reflected the light down on to the plants. The position of individual pots relative to the light source was kept constant. The control pot was kept continuously in the open.

At weekends (Saturdays and Sundays) all pots were left in the open; thus light treatment occurred on five consecutive evenings only of each week. Facilities for daily illumination for constant periods were unfortunately not available, and the period of additional illumination given varied considerably. The average extra daily illumination (reckoned from 1830 hours daily) was 6½ hours but it varied on different days from 4 hours to 11 hours.

After two months of this treatment flower bud formation was observed on all

the treated plants. Flowers matured during the ensuing month of continued light treatment. The heights of flowering stems varied from 15 inches to nearly 24 inches while the plants in the untreated pot maintained their normal non-flowering habit of 3 to 4 inches.

Specimens of the flowering stems have been sent to the Royal Botanic Gardens, Kew, for identification and duplicates have been given to the Department of Agriculture for record.

THE HISTORY OF A TEA FIELD

F. C. CHARNAUD

LUCKYLAND ESTATE.—Uda-Pussellawa — No. 2 Field=32 acres.

YIELD PER ACRE for Season 1945. — 2,208 lbs. Tea.

Year	Yield per acre of No. 2	Average Yield for Pruning Cycle	Yield per acre Whole Estate	Average Yield for Pruning Cycle
1920	592 P.		573	
1921	656	749	549	580
1922	1000		618	
1923	724 P.	925	649	
1924	1125		711	680
1925	706 P.		691	
1926	1207	984	766	747
1927	1038		783	
1928	707 P.		818	
1929	1428	1157	900	852
1930	1337		838 R.	
1931	923 P.		860 R.	
1932	1542		930	
1933	1290 R.	1246	841 R.	861
1934	1230 R.		812 R.	
1935	858 P.		916	
1936	1559		975	
1937	1644	1390	987	1003
1938	1498		1136	
1939	991 P.		1162	
1940	1730		1209	
1941	1845	1566	1042 R.	1179
1942	1700		1305	
1943	1140 P.		1225	
1944	1782	1782	1237	
1945	2208		1262	
1946 Estd	2000		Estd. 1262	
P. denotes Pruning				
R. denotes Restricted				
Percentage of Increase of No. 2 Field				137.28%
Percentage of Increase whole Estate				114.83%

NOTE.—We publish this summary of the history of a tea field in the belief that details will be of general interest.

We have not examined the detailed records, but the Calendar year yields suggest that one of the reasons for the success of this field is that it conforms to the "late maximum" pruning cycle pattern referred to in Dr. Eden's article published in this number.—Ed., T.Q.

Age.—Planted in tea in 1897 by the late F. J. Whittall and John Gordon with local seed from bearers of a Manipuri hybrid grown on Rappahannock, Uda-Pussellawa, which produced a mixed, medium-sized jat. It was planted 3×4 feet up and down the main slope of the land giving an average of 3,500 bushes to the acre, with very few vacancies.

Situation.—Easy lay of land, facing South to South East, 4,400 to 4,800 ft. above sea level.

Climate.—Falling into the North East area of the Island. Uva climate with an annual average rainfall of 95 inches, of which half normally falls during the two months of December and January. Usual Uva drought in June to September with fairly strong, dry winds.

Soil.—A good black loam with fair depth, containing a proportion of quartz and, in patches, very rocky. Originally it carried a thick cover of Mana grass and scrub.

Pruning Cycle—Up to 1920 it was on a 2-year cycle, for the next 10 years, up to 1930, it was on a three-year cycle and since 1931 on a 4-year cycle. It has always been pruned during the months of June-July. It has never received a heavy cut down but every-bush has been pruned according to its merits, removing part of the old knotted wood at each pruning and always preserving as much new wood as possible and spread of frame.

Artificial Manure.—Up to 1929 it received an annual application of 30 to 38 lb. nitrogen and corresponding phosphoric acid and potash. Since 1929, when it entered a 4-year pruning cycle, the nitrogen contents were increased to an average of 48 lb. but the applications were increased to six in the 4-year cycle. This lasted until 1938 when for various reasons the applications were reduced to 5 in a cycle of 4 years,

but the average plant food allotted to the cycle remained the same. No application has ever been given 6 months before or 6 months after pruning. Since the Fertiliser Rationing Scheme was introduced the allocation of nitrogen has been reduced to 42 lb. per annum but, owing to difficulties of transport, etc. during the past 4 years two applications were completely missed while some applications had to be undertaken out of season.

Grevilleas and Nitrogenous Trees.—It was originally planted in grevilleas every 12 lines of tea and every 8th bush in the line or 48 ft. \times 24 ft. All these old grevilleas were gradually cut out between 1923 and 1927 and new ones replanted from 1930. Dadaps were first planted in 1923 in every 4th line of tea and every 4 bushes in the line or 15 ft. \times 15 ft. In the hollows where they grew too luxuriously every other dadap was killed some 10 years ago. The balance were continuously lopped at times of forking and controlled in between applications. All these old dadaps were killed and removed just prior to pruning in 1943, and this may be one factor which has contributed to the jump of 363 lbs. per acre last season when compared to the same cycle year in 1941.

Bush Manure.—It has always been planted with a rotation of some green manure plant and all loppings forked in.

Prunings.—For the past 17 years all prunings have been buried in holes. Before that they were forked in after drying.

Compost.—For two cycles in 1935, and again in 1939, this field received compost at the rate of 7 tons per acre. Since then all poor patches have received some form of additional cultivation.

Maize Interplanted.—30 acres out of the 32 were planted in maize after the pruning of 1943 and its yield of maize was 21 bushels per acre. For a time during 1944

the field appeared tired, but it soon recovered when the roots of the tea found their way into the remaining compost applied in the maize holes. With the maize stocks and some yellow daisy, 98 tons of compost was manufactured and forked in with the artificial in the autumn of 1944. This may also have contributed towards the recent increase of crop.

Roads.—If an example is needed that internal car roads increase yield through the help they afford to supervision, this field supplies it. It has a car road con-

structed in 1930 zig-zagging through its entire length.

Drains.—These, for years, have been in first class order and are fitted with stone built blocks: I have never seen them run dirty.

Terracing.—All the road banks are protected with a permanent dressed stone terrace and almost all drain banks have been built up with good large stones.

Weeding.—Clean throughout, and no oxalis or drymaria.

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 17-4-46

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Ceylon Chamber of Commerce Rooms, Colombo, on Wednesday, 17th April, 1946, at 2-30 p.m.

Present—Mr. R. C. Scott, C.B.E. (Chairman), Mr. C. J. D. Lanktree, C.B.E., E.D., C.C.S., representing the Hon'ble the Financial Secretary, the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.), the Chairman, Planters' Association of Ceylon (Mr. R. Singleton-Salmon), the Chairman, Ceylon Estates Proprietary Association (Mr. E. E. Spencer), Major J. W. Oldfield, C.M.G., O.B.E., M.C., M.S.C., Mr. D. T. Richards, Mr. H. S. Hurst and Dr. R. V. Norris (Director and Secretary).

(1). The Notice convening the Meeting was read.

(2). The Minutes of the Meeting of the Board held on the 22nd December, 1945, were confirmed and signed.

Letters expressing inability to be present were tabled from Mr. F. Amarasinghe and Mr. Gorton Coombe. The Chairman also informed the Board that Mr. R. C. Kannangara, M.S.C., was unfortunately ill in hospital and could not be present.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

(i): Board.

(a). Reported that Major J. W. Oldfield, who was shortly proceeding on leave, had submitted his resignation from the Board and that the Ceylon Estates Proprietary Association had nominated Mr. W. H. Attfield to fill the vacancy created.

The Chairman said Major Oldfield had taken a notable part in the formation of the Institute and was the first Chairman. At a later period he again acted as Chairman during the absence of Mr. Coombe on leave. He had been continuously a member of the

Board since the Institute was started and was, in fact, the only member of the original Board now serving.

Mr. Scott said Major Oldfield had always been progressive in outlook and constructive in suggestion and, on behalf of the Board and the tea industry as a whole, he wished to express to him the most grateful appreciation for all he had done to promote the interests of the Tea Research Institute.

The Chairman of the Planters' Association, in associating himself with Mr. Scott's remarks, expressed the hope that Major Oldfield would be able to give further assistance on his return to Ceylon.

The Director also expressed to Major Oldfield the appreciation of himself and the staff for the support he had invariably given to their work.

Major Oldfield, in reply, thanked those who had spoken for their references to his work on the Board. He said he had always taken the greatest interest in the work of the Institute and in the staff whom he wished to thank for their assistance and co-operation. He would be returning to Ceylon and would be glad to give any assistance in his power to the Tea Research Institute.

(b). Reported that Mr. W. H. Gourlay had resigned from the Board and that Mr. D. T. Richards had been nominated by the Ceylon Estates Proprietary Association to fill the vacancy.

The Chairman thanked Mr. Gourlay for his services and welcomed Mr. Richards on his return to the Board.

(c). *Acting Chairman* — Mr. R. Singleton-Salmon was unanimously elected to act as Chairman of the Board during Mr. R. C. Scott's absence on furlough.

(ii). *Estate and Experimental Sub-Committee.*

(a). Mr. H. S. Hurst was nominated a member of this Committee to fill the vacancy created by the resignation of Mr. R. G. Coombe.

The Chairman reminded members that Mr. Coombe had been a member of the Committee since its formation and asked the Board to record their grateful appreciation of Mr. Coombe's long and able assistance.

(b). Mr. S. Bolster was nominated to act on the Committee during the absence of Mr. Scott on furlough.

(c). Mr. T. Kane was nominated to act for Mr. R. H. Horne proceeding on home leave.

(iii). *Finance Sub-Committee.*

(a). Mr. Attfield was appointed a member of this Committee *vice* Major Oldfield resigned.

(b). Mr. D. T. Richards was appointed to act in the temporary vacancy created by Mr. Scott proceeding on leave.

4. ACCOUNTS

Reported that as the Audit was not yet finished, the accounts for 1945 would be presented at the next meeting.

The accounts to 28th February, 1946, had been issued to members. It was decided a further sum of Rs. 30,000 should be invested at the discretion of the Chairman and Director.

5. ST. COOMBS ESTATE

(a). *Visiting Agent's Report dated the 6th March, 1946* — had been issued to members.

The Chairman, who said the report had not yet been considered by the Experimental Committee, invited comments.

In reply to Major Oldfield, who referred to the remark on plucking, the Director said

this matter had already been before the Experimental Committee. Dr. Eden (the Acting Superintendent) had been going into plucking records and had been asked to submit a report to be considered at the next meeting of the Experimental Committee.

The Chairman and Mr. Hurst both referred to the suggestion of the Visiting Agent in regard to small family weeding contracts and supported the proposal.

Mr. Salmon agreed and pointed out that this could be arranged under agreement with the Labour Department. Such contracts would be outside work on the check-roll. He thought arrangement of this kind would be welcomed by the labour, providing as it did an opportunity to earn additional pay.

Major Oldfield also supported the proposal. He pointed out that when compulsory holidays came into force, the best workers would suffer and such outside work would enable them to recoup themselves.

(b). *St. Coombs Results for 1945.*—Preliminary figures for St. Coombs Estate for 1945 were tabled and there was general agreement that the results were very satisfactory, considering the severe drought which was experienced in the earlier months of the year.

6. MINUTES OF THE MEETING OF THE ESTATE AND EXPERIMENTAL SUB- COMMITTEE HELD 2-3-46

The Director of Agriculture strongly supported the view expressed in the Committee that clean weeding should not be adopted.

Mr. Salmon stressed the need for further work on the subject of weeds. Personally, he was alarmed at the risk from grasses when clean weeding was not adopted and, while fully appreciating the necessity for measures to combat soil erosion, he

would prefer scrapers to grass. His experience was that selective weeding, as generally practised, led to the introduction of grasses and he thought that soil erosion might be controlled by other measures, such as terracing and draining.

The Chairman supported Mr. Salmon's views. The Director of Agriculture, on the other hand, considered that a soil cover was the most effective protection against soil erosion. He said it was not unlikely that legislation would eventually be introduced to enforce anti-erosion measures.

The Director said that consideration of the question should not be confined to the alternatives of clean weeding and selective weeding as now practised. The latter was not always very effectively carried out and he agreed that difficulties in regard to grasses arose. Actually the Institute's field experiments now in progress covered a much wider field, and were designed to examine different methods of cultivation which, while providing protection against soil erosion, might be effective in controlling grasses and economical in labour and cost.

Major Oldfield stressed the importance of such work and asked the Board to record its view that this should form a major item of experimentation. To this the Board agreed.

7. SENIOR SCIENTIFIC STAFF

Superintendent, St. Coombs Estate.—(Mr. J. A. Rogers).

The Chairman reported that Mr. Rogers had suffered from a severe heart attack while on leave in Australia. He had returned to Ceylon at the beginning of April but was still unfit for work. He had submitted a medical certificate from Dr. Prest of Adelaide, who had attended him throughout his illness, recommending three months' sick leave.

The certificate in question was read to the Board and it was decided that the sick leave asked for be granted as from 1st April. It was also decided that Mr. Rogers should be asked to appear before a medical board toward the end of this leave and a report obtained as to whether Mr. Rogers would be fit to resume his work on St. Coombs.

The Director said in these circumstances it would be desirable to make other acting arrangements as Dr. Eden could not, without detriment to his own work, continue to run the estate.

It was decided that the Chairman, Visiting Agent and Director be authorised to make an acting appointment, the terms of which should be Rs. 750 per mensem plus dearness and other regular allowances, Provident Fund and proportionate contribution towards passages and furlough pay.

Mycologist.—(Dr. T. E. T. Bond).

Reported that by means of Circular No. A. 1/46 dated 27th March, 1946, the Board had agreed to accept Dr. Bond's resignation with effect from the 8th July, the date when his accumulated leave expired. The Director's proposals in regard to filling the appointment had also been approved. An appropriate advertisement had, therefore, been sent to "Nature" and the following gentlemen had been asked to act as an Advisory Committee to interview candidates and make recommendation to the Board; Prof. Sir F. L. Engledow, F.R.S., Prof. F. T. Brook, F.R.S., and Dr. Kenneth Smith, F.R.S.

Biochemist.—Reported that Mr. J. Lamb had proceeded on home leave on the 7th March, 1946.

8. RESOLUTION SUBMITTED BY MR. R. C. KANNANGARA IN REGARD TO THE PREPARATION OF A MANUAL ON TEA

In view of Mr. Kannangara's absence, consideration of this was deferred to a later date.

9. REPORT OF THE BOARD FOR 1946

The Chairman said this would be submitted as soon as the audited accounts were received.

10. WORK ON SMALLHOLDINGS

The Director referred to the difficulty in obtaining quarters for a smallholdings officer in the Morawak Korale. After discussion with the Chairman of the Morawak Korale Planters' Association it had been decided the officer should be stationed if possible near Deniyaya or Kotapola.

Mr Boange would proceed to Deniyaya immediately after the Easter holidays and would temporarily be accommodated at the Deniyaya Resthouse until other arrangements could be made.

II. SUB-STATION FOR THE LOW-COUNTRY

The Director reported that he had attended a meeting of representatives of the low-country tea districts at Ratnapura on the 23rd March. The requirements of the low-country areas had then been fully discussed, the chief demand being for work on (a) soil management generally and (b) pruning problems.

The above Committee would send in their suggestions to the Planters' Association of Ceylon, and the Board would no doubt receive these in due course.

12. ANY OTHER BUSINESS

(a). *Index to T. R. I. Publications.*—In reply to Major Oldfield, the Director said the preparation of a general index, supplementary to that already issued, had been begun.

(b). *T. R. I. Car.*—The Director said the office car, which has now covered nearly 75,000 miles was no longer reliable and also necessitated considerable expenditure in repairs and upkeep. Sanction was requested for the purchase of a new car.

It was decided that the Director should apply to the Commissioner of Motor Trans-

port for the necessary permit and the Finance Committee be authorised to approve the necessary expenditure.

The Meeting then concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS,

Secretary.

NOTICES.

VISITORS' DAYS

The second and last Wednesdays in each month are Visitors' Days at the Institute and it is hoped that, as far as possible, visits will be made on these days. Appointments should be made for visits on other occasions.

GUEST HOUSE

The Tea Research Institute Guest House is again available for visitors to the Institute. Applications for accommodation should be sent to the Director, T. R. I. St. Coombs, Talawakelle. Meals cannot be provided unless at least twenty-four hours' notice is given.

